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United States
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PROPOSED PRIVATE ROAD
SYSTEM IN THE BROWNS
RIVER WATERSHED, VERMONT

Economic Research Service
Forest Service
Soil Conservation Service
and
Cooperating Agencies
Vermont

A technical report of the
Agricultural Runoff in Selected
Vermont Watersheds Study



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PROPOSED PRIVATE ROAD SYSTEM
IN THE BROWNS RIVER WATERSHED, VERMONT

Technical Report

Agricultural Runoff in Selected Vermont Watersheds Study

U. S. Department of Agriculture

Economic Research Service
Forest Service
Soil Conservation Service

In cooperation with

State of Vermont

Agency of Environmental Conservation
Department of Agriculture

Forest Service
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August 1982

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I. INTRODUCTION

In Vermont, as in the Northeast in general, the combination of small parcel ownership of commercial forestland and difficult terrain poses a major problem to landowners, loggers, and foresters in constructing access roads. All too often access roads are constructed in poor locations over unfavorable soils with excessive grades simply because no other route exists on the owner's land. Such roads at best provide only temporary and difficult access to the forestland at a high cost. Severe erosion of the road is almost certain, resulting in the eventual loss of the road and the landowner's investment therein. Successive harvests of a woodlot may eventually be represented by a number of more or less parallel roads, each washed out and abandoned after cutting. This situation often occurs on adjacent ownerships, indicating an opportunity for cooperative road construction that was never realized.

A more efficient use of Vermont's resources would be to plan and build a road to serve a large area of forestland that logically may be considered a single logging unit. Without the limitations imposed by property lines, such a road can be constructed over the optimum route for timber access, using reasonable grades and with adequate drainage. A road thus properly sited and constructed can be retained indefinitely at low maintenance cost, providing the landowners with present and future access to their property for whatever purposes they might wish. At the request of the sponsors, this study has investigated some of the aspects of a private road system providing access to forestlands in more than one ownership. Such a road system could offer substantial advantages to the landowners involved; advantages which may overcome

the objections that landowners can be expected to raise because of some loss in personal control over their lands.

II. ADVANTAGES OF COOPERATIVE ROAD CONSTRUCTION

What are some of the advantages that a cooperative road provides to the landowners? For one thing, less area is taken up by the access roads. Consequently, the landowners have more land available for profitable uses such as timber production. Greater flexibility in locating the road enables gentler grades to be used, and better drainage provided.

Erosion is thus greatly reduced and the potential for washout and loss of the road eliminated. In a study of erosion and sediment from logging roads in Vermont ^{1/} the access roads (log roads) comprised 12 1/2 percent of the lineal length of road system (skid trail, skid road, log road) that was eroding on harvesting operations. Access roads are used to haul logs to a permanent, public road for further transport to a mill. These access roads contributed 43 percent of the erosion rate however. After construction of the initial access road system, the erosion rate from timber harvesting could be substantially reduced. Although the initial construction costs for a good road may be higher, a permanent, usable road is a capital improvement that will increase property value and will result in higher stumpage prices for timber harvested in future cuts, provided the timber is managed and marketed in a professional manner. And of course, economies of scale in construction and maintenance are possible when several landowners cooperate in developing a joint access system for their properties.

^{1/}Rutherford, Susan. 1981. Agricultural Runoff in Selected Vermont Watersheds. Erosion and Sediment Production from Logging Roads in Vermont.

A well-constructed road system can improve access to his property for recreation (hiking, hunting, birdwatching, etc.), for firewood removal, and for future commercial harvests. Creating openings in a closed forest canopy can improve wildlife habitat on his property. Thus, the landowner should be aware that the capital expenditure required for a good road system is offset not only by the income gained from selling timber, but also by these future amenities which such a road system makes accessible.

III. POSSIBLE DISADVANTAGES

The obstacles to the development of a private, multi-owner access road can be numerous. Forest landowners differ frequently in their objectives for forest ownership. Different objectives result in differing intensities of management and use of the lands. A shared road raises the possibility of unwanted traffic on the properties involved. Some of the landowners may be left with longer travel distances to their parcels or with less direct access between their homesites and the contiguous acreage. The construction, maintenance, and management of fences and gates can be complicated by a cooperative road. The benefit/cost ratio for different owners can often be unequal but should be adjusted to reflect the value of each owners interest. And finally, many landowners are reluctant to grant long-term, binding rights-of-way.

IV. DISCUSSION AND SUGGESTED PROCEDURE

Many of these problems may be ameliorated through the contractual arrangements made between the landowners. Some informal, tentative cooperative roads do exist. Good neighbors may rely on the spoken word and handshake,

but such verbal, temporary rights-of-way are inadequate and are not recommended. More formal and permanent roads might result from an existing cooperative for production and marketing of farm crops, or where a few landowners with contiguous holdings share particularly close cooperation in a variety of their land management activities. However, this would not remove the need for formal agreements covering such things as cost sharing for construction, maintenance, use, etc.

When more than two private owners wish to formally share a road, they should consider an association. The association should be organized to accept rights-of-way instruments and funds for construction and maintenance, provide a governing body to insure that costs are fairly apportioned and to regulate use as necessary, with due regard for the interests of the people involved. Formation of such an association is clearly a complicated undertaking and will require guidance of an attorney skilled in such matters. At the very least, the cooperative road agreement should include an exchange of rights-of-way, and plans for funding construction, use, and maintenance. While there needs to be some provision to dissolve the association, it should not be possible for one landowner to withdraw unilaterally or to exert unreasonable control over the use of the road by other members of the association.

The identification of forestland presently without adequate road access is the first step towards forming an association. A preliminary study was made in the Browns River Watershed for this purpose. The state forester's office selected this watershed because the small holdings of commercial forestland in the basin are typical of Vermont.

V. DESCRIPTION OF THE STUDY AREA

The Browns River Watershed is located principally in Chittenden County in northwestern Vermont. In the north, 840 acres extend into Franklin County and 570 acres into Lamoille County to the east. The basin lies 10 miles northeast of the city of Burlington and encompasses approximately 59,300 acres. Most of the watershed is within the Champlain section of the St. Lawrence Valley Physiographic Province. However, the rugged eastern part is within the Green Mountain section of the New England Physiographic Province. The general topography is gently rolling to mountainous terrain, interspersed with low-lying fertile valleys underlain by water deposited material. Elevations range from 4,393 feet above mean sea level at the top of Mt. Mansfield, to 320 feet above mean sea level at the confluence of the Brown's River with the Lamoille River.

Present land use is as follows:

<u>Land Use Group</u>	<u>Present Land Use</u>	
	<u>Acre</u>	<u>%</u>
Forest	45800	77
Pasture	9800	17
Wetlands	1500	2
Idle	1200	2
Crop	800	1
Water	100	*
Other	<u>100</u>	<u>*</u>
Total	59300	

*Less than 1%

As the Land Use Table shows, approximately 77%, or 45,800 acres, of the watershed is in forest cover. Hardwood stands, occupying 54% of the area, consist mainly of the northern hardwood, beech-birch-maple types with associates of ash, red maple, aspen, elm and black cherry. Natural softwood stands and established plantations of spruce, fir and white pine occupy 29% of the area. The remaining 17% consists of mixed stands of hardwoods and softwoods. About 43% of the forest stands are of saw-timber size, 21% in pole size stands and 34% in stands of seedling and sapling size and 2% non-stocked.

A. Problems and Needs

The primary forestry problem in the watershed is a fragmentation of the resource base. The sub-division of forestland into long and narrow ten acre residential plots is occurring along many of the existing roads in the area. This sub-division is effectively eliminating timber management by reducing the acreage economically feasible to log. In addition to causing a problem of accessibility to the forest products on the ten acre lots, it often restricts access to land located in back of the developments. High erosion rates (35 t/ac/yr) are possible when roads are installed on these narrow plots because of steep terrain and limited access.

Landowner surveys reveal that the majority of residential landowners have no desire to manage their small holdings for any type of timber production. Many of those same residential owners use firewood to heat their homes. With proper management, these small landowners could grow part of their own firewood and still maintain an aesthetically pleasing

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wooded ten acre house lot. In areas with high quality sawtimber, a possible solution may be to encourage landowner cooperatives, allowing loggers access to combined parcels of timber over multi-ownership roads.

In other areas of the watershed indiscriminate firewood cutting is a problem which needs to be addressed. Without technical assistance from foresters, potentially valuable future sawtimber trees are often removed for firewood in pole size stands. The tremendous demand for fuelwood in this part of the state provides an excellent opportunity for increasing the quality of the extensive hardwood forest. Much needed thinnings of these dense stands could yield firewood on a continuing basis to the local population.

In addition to increasing the availability of technical assistance for the landowners, a strong information and education effort is needed to insure proper selection of trees for firewood removal. Present and potential firewood users must be identified and marking and marketing services provided.

B. Present Land Treatment and Management

Forestland treatment measures accomplished under existing cooperative programs on private land during the last ten years are as follows:

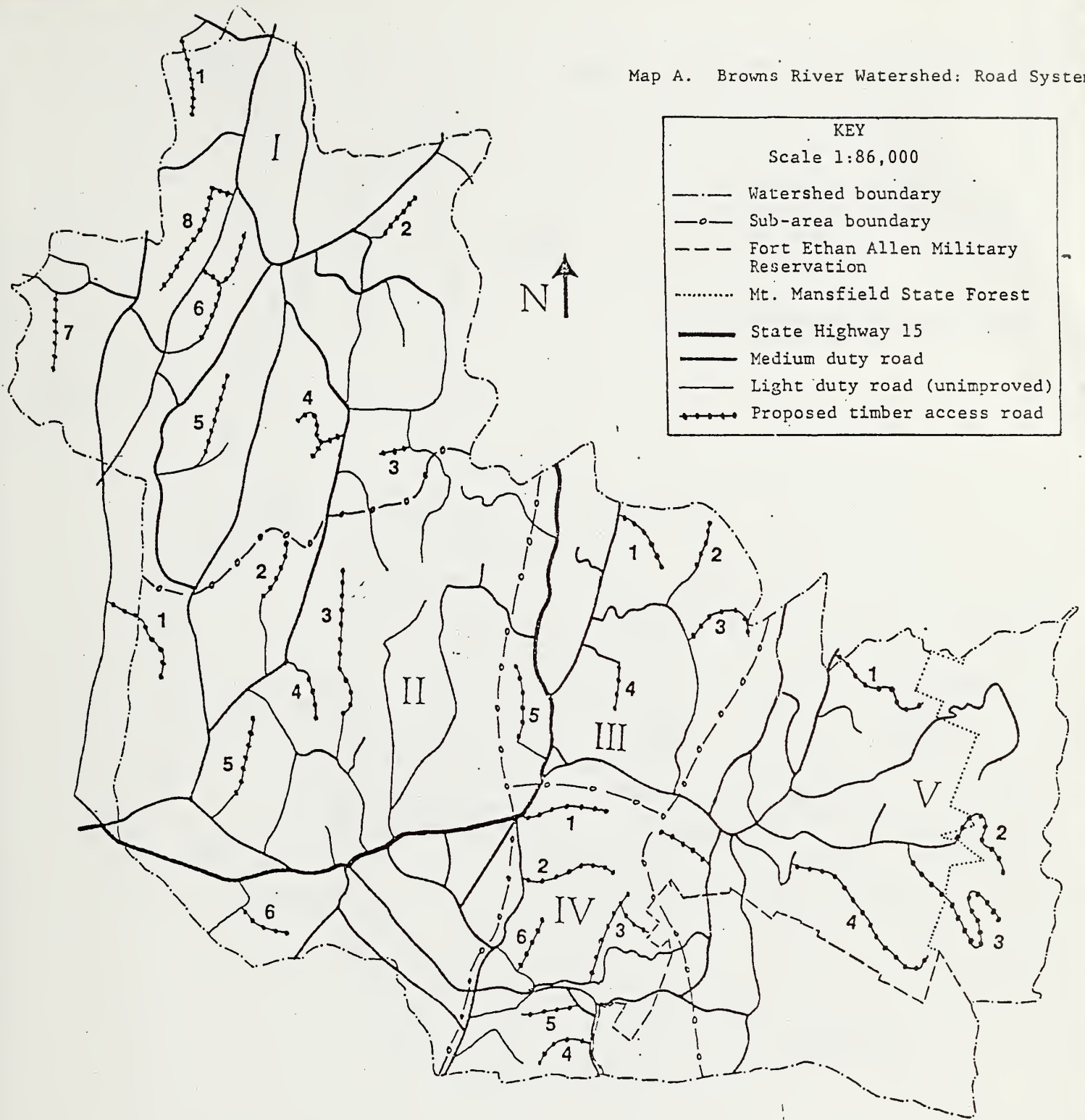
290 acres of tree planting, 510 acres of stand improvement, 885 acres of harvest and intermediate cuts, and 49 miles of logging road and skid trail layout and erosion control. Fifty nine landowners have had management plans prepared on 20,400 acres, exclusive of the Fort Ethan Allen Military Reservation.

C. Procedure

The first step in developing a road system to provide access to the forestland in the Browns River Watershed was to determine the extent of the present road system. This was done using topographic sheets and aerial photographs. Overlays were developed which show the existing roads (Map A) and the major permanent drainages (Map B). These overlays were then placed over aerial photographs (Figure A) to determine the areas that are presently in forestland and where additional roads were needed for forest management. The total drainage area was divided into five sub-areas. Within each sub-area the proposed roads were assigned a number. Each road was then located on a detailed soils map (see Appendices I & II). The degree of limitation and major limiting factors for road building were listed for each soil type that the proposed road crossed. The total miles of roads needed is approximately 31 miles (Table 1 in Appendix). Actual distances may vary for individual roads when they are located on the ground.

The generalized road locations provided in this study should be sufficient to identify the landowners involved and provide a basis from which to begin the organizing effort. Actual on the ground location and the design standards of this road will have to come after the institutional arrangements have been successfully completed. Methods of funding and construction will have to be determined by the landowners involved. Factors affecting these decisions will be, among others, the nature and extent of the timber to be served, whether or not the road can be built in stages over a period of years, the availability of ready cash on the part of the owners, and road building equipment that they may have at their

Map A. Browns River Watershed: Road System

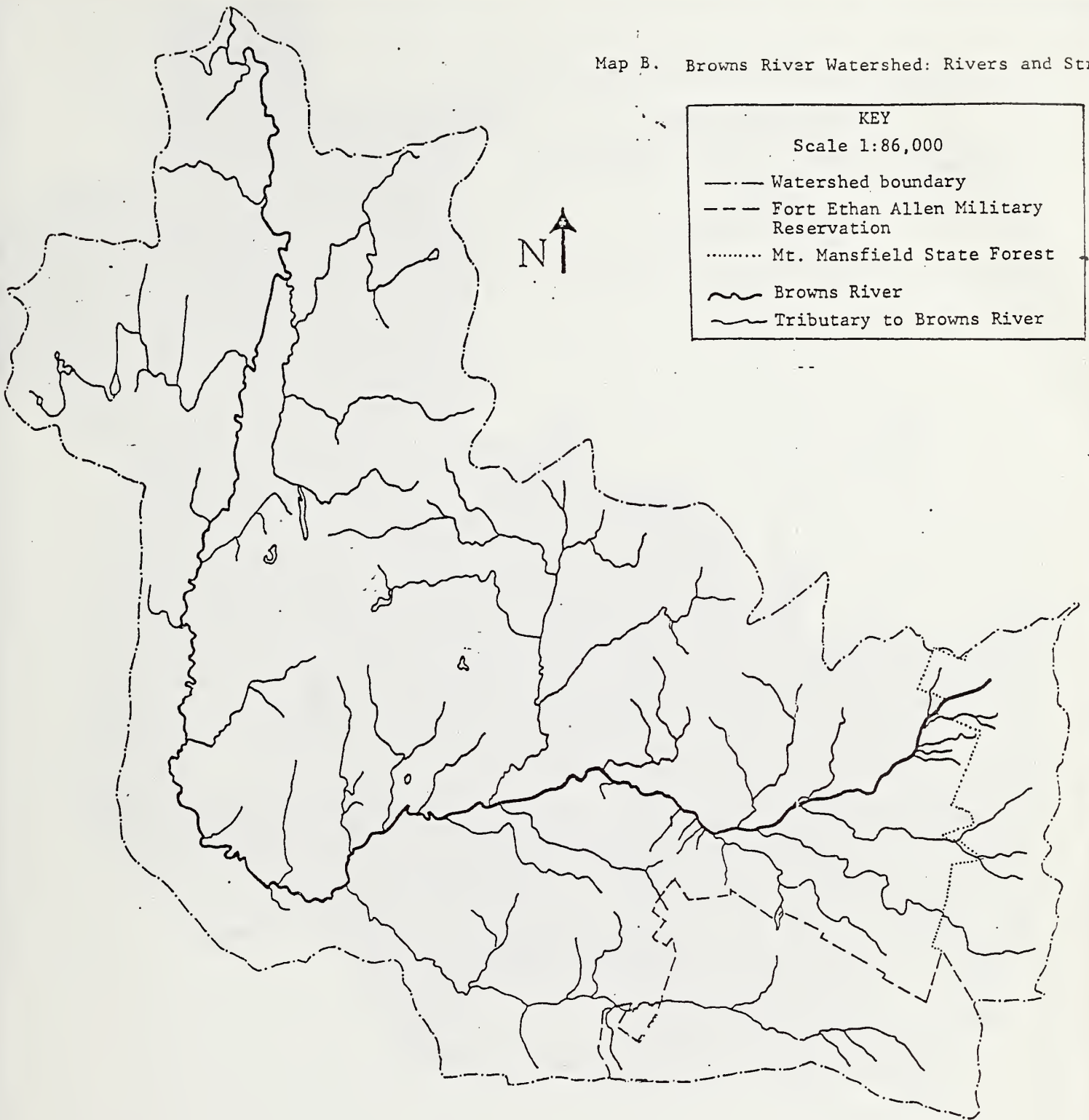


Map B. Browns River Watershed: Rivers and Stre.

KEY

Scale 1:86,000

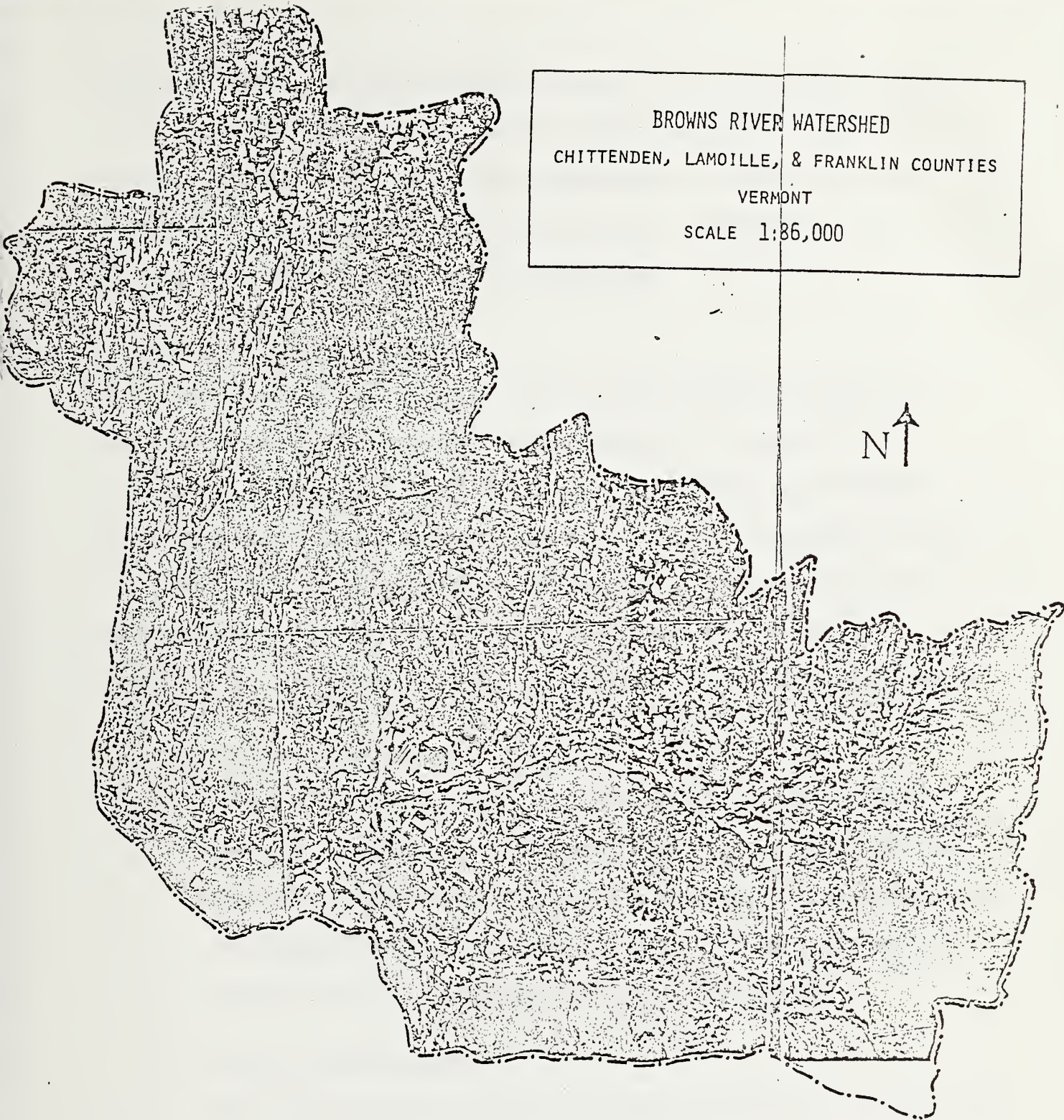
- Watershed boundary
- Fort Ethan Allen Military Reservation
- Mt. Mansfield State Forest
- ~~~~ Browns River
- ~~~~ Tributary to Browns River



BROWNS RIVER WATERSHED
CHITTENDEN, LAMOILLE, & FRANKLIN COUNTIES

VERMONT

SCALE 1:86,000



disposal. Because of the preliminary nature of the road locations and variations possible in types of roads suitable for access roads (i.e. single or double track; all weather, intermittent or winter use only) no cost estimates are provided. Up-to-date cost estimates can be secured when specific road plans are developed.

D. Planning the Logging Road

The actual planning and design of the road must encompass many considerations. Technical publications such as "Guides for Controlling Soil Erosion and Water Pollution on Logging Jobs in Vermont" and "Permanent Logging Roads for Better Woodlot Management" should be consulted. Their recommendations and guidelines are most useful when blended with local experience and observation. The road planner may foresee problems arising from road construction by consideration of the following items:

1. The needs for the road

For what purposes will the road be used? In timber harvesting, how much volume will be removed; are landings needed? Will the road also be used for agricultural purposes; is there a potential for compaction damage from grazing animals? How close is the public road; are there weight or other limitations?

2. Traffic characteristics

What are the typical vehicle's weight and dimensions, and turning radius? Will the road be all weather, or seasonal? A lower cost road may be significantly damaged by a single pass during wet conditions, therefore means of regulating traffic by the owners may be necessary.

3. Visible elements of the road

What will be the width, the tightest curve, the grade of the road? Are turnouts or turnarounds needed? A logging road should intersect a high speed road nearly perpendicularly and on a slightly uphill grade. How may the aesthetic qualities of the property be preserved or enhanced by road construction?

4. Structures and special features.

What is needed to provide good drainage and sediment control: culverts, bridges, fords, dips, settling basins, filter areas? Are cattleguards, gates or signs needed? Will surfacing or fill material need to be hauled?

5. Existing features and obstructions.

What physical or landscape features will have to be dodged, modified, or replaced during road construction: water or sewer lines; power or telephone lines; fences, pastures, and cultivated fields; wells, streams, lakes; dams and ditches; buildings; character trees or other landscape attributes?

6. Road maintenance

Plans for maintenance should be made. In use, maintain first for drainage, then for traffic. Vegetative cover should be maintained; chuck holes may be filled individually or, if used, funding and equipment availability permit, full width blading may be preferred; any obstruction in the drainage pattern must be corrected without delay. Prompt and careful

hand work is often more effective than machine work especially if the machine work is delayed.

7. Financial considerations

The objective in financial planning of the road is to achieve the greatest benefits at the lowest cost. Should the construction be in stages in order to spread out the financing? How much money is required for construction, and how much should be budgeted for maintenance? When is equipment and expertise available, and who has it? What are the effects of the inflation and interest rates?

E. Logging Roads After Construction

Proper use, maintenance, and closure of logging roads are sometimes not given as much attention as the planning and construction phases. Some ideas on these three aspects of road ownership are given below.

F. Use

Travel the road in such a way that it is in as good condition after use as it was before. Be especially cautious when the road is soft, as after a rain or during spring breakup. Protect road, culverts, ditches, fences, trees, signs and other things of value. "Roll the road" or drive over the entire usable road width to compact the whole road. Driving in the same tracks may be easy at first, but this causes ruts. Be aware of maintenance needs. Call attention to developing deterioration, which can often be corrected more easily before a complete failure.

G. Maintenance

This relates to retaining the value and usefulness of road as constructed.

Improvement, such as widening, is not included. Each road is different and will have different maintenance requirements.

Maintenance will be minimized if:

- the road can be built several months before use,
- there was good planning and construction with maintenance considered,
- there is timely and proper use and repair.

Drainage must be kept in good condition. Although a flat running surface may be required during heavy hauling, ditches, culverts and dips should be maintained. With less intense use, the surface should be crowned, outsloped or insloped with frequent relief dips. Inspection and minor maintenance during heavy prolonged rainfall may be necessary, especially on a new road.

Special attention should be given at the beginning of seasonal closure. Much damage may be done in order to get out the last few loads before shutdown. The landowner and logger should recognize the possibility additional road and watershed damage, and correct any that occurs immediately so the road will drain correctly and will not become a waterway during seasonal closure.

Surfacing of gravel or crushed rock often permits a smoother, stronger travel-way and protects against erosion. Surfacing material should be relatively hard, heavy, and sharp edged of graduated sizes with the largest piece smaller than the thickness of the layer. However, fords may be of very large material, such as one foot for the smallest dimension.

With careful placement, this size may remain in place even with rapid water flow. River or glacial gravel is often used to reinforce wet spots; it usually works well, especially if there is a good mixture of sizes.

Smoothing the surface is sometimes necessary. Appropriate equipment may be a dozer blade, drag, or grader. The motor grader is ideal for restoring crown, smoothing surface, some ditch or backslope work, and scarifying. Work is best done when the road is moist, but not excessively wet. Typical crown shaping usually is done with the first pass from the edge toward the center, then the second pass from the center out. A berm should never be left between the road and ditch. Sometimes repair of chuckholes requires first scarifying or cutting to the bottom of the hole, before the shaping passes described above.

Ditches are sometimes pulled (graded) to lower ditch bottom, recover fine material, or remove excessive vegetation. This work should not be routine, but done as necessary. Caution should be exercised to not undercut the cutbank above the road. Any grading or other repair work must be in a manner which will save fine material on the roadway.

Managing the vegetative cover in areas sensitive to erosion or appearance is important, particularly during construction and closure. This may include seeding and fertilizing or even fencing, mulching, liming or mowing. Some brush cutting is typically required intermittently.

H. Closure

Where closure is desirable, the following steps should be taken as appropriate.

1. Remove temporary culverts and bridges. Waterway should be clear and deep enough to carry flood water.
2. Add waterbars as needed, especially one at beginning of steep grades and just above landings and at junction with any lower road.
3. Remove or assure breaks in fenders, berms, or outside shoulders. Continuous outsloping is often the ideal.
4. Direct water into good filter areas.
5. Smooth roads and landings for natural drainage. Excessive smoothness with compaction may hamper revegetation.
6. Establish cover on landings and, where necessary, roads. Consider erosion, wildlife, and appearance.
7. Inspect and maintain after each of first several heavy rains, then at least each spring afterward.
8. Sign and gate as appropriate.
9. Have appropriate terms of use, maintenance and closure covered in agreements.

Some modification of the above will permit limited dry season or winter use.

TABLE I

PROPOSED ROADS

SUB AREA	ROAD NUMBER	LENGTH		1974 CHITTENDEN CO. SOIL SURVEY MAP NUMBER
		FEET	MILES	
I	1	6600	1.3	7
	2	2000	.4	11
	3	1900	.4	16
	4	5300	1.0	16
	5	3200	.6	16 & 23
	6	8700	1.6	11
	7	5900	1.1	10
	8	7500	1.4	11
		<u>41100</u>	<u>7.8</u>	
II	1	8300	1.6	22
	2	5600	1.1	23 & 16
	3	3200	.6	23
	4	2800	.5	23
	5	8300	1.6	23 & 29
	6	2500	.5	29
		<u>30700</u>	<u>5.9</u>	
III	1	4600	.9	17
	2	2500	.5	17
	3	5300	1.0	24
	4	4100	.8	24
	5	4000	.8	24
		<u>20500</u>	<u>4.0</u>	
IV	1	7700	1.5	30
	2	7900	1.5	30
	3	7400	1.4	30 & 36
	4	4000	.8	36
	5	2100	.4	36
	6	4000	.8	30
		<u>33100</u>	<u>6.4</u>	
V	1	7100	1.3	25
	2	5700	1.1	31
	3	9500	1.8	31
	4	10700	2.0	31
	5	5300	1.0	30
		<u>38300</u>	<u>7.2</u>	
	TOTAL	163700	31.3	

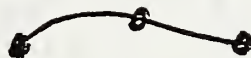
APPENDIX

The following overlays were designed to use with the January 1974 Soil Survey of Chittenden County. The map numbers shown on the bottom of each overlay correspond with the map numbers in the back of the survey report. Small corner marks were drawn to line up with the corners of the map. Some roads extend on to more than one map and are shown in two segments (Example: Sub Area I - Road 5).

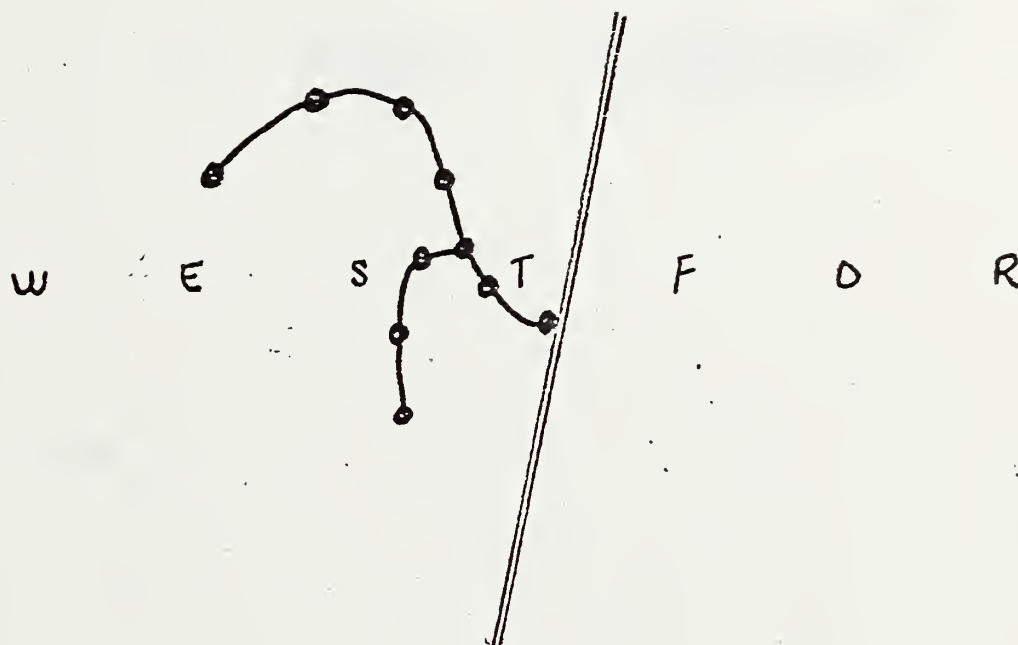
Sub Area I		Road 1
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.



Sub Area I		Road 2
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
MnB	Hinesburg fine sandy loam 3-8% slope	Moderate: slopes, loamy subsoil or substratum.
PsC	Peru Extremely stony loam 0-20% slope	Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.



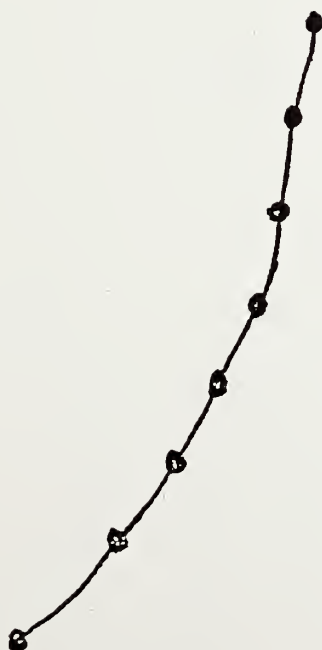
Sub Area I		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. mainly slope. Marlow - Severe: topography, mainly slope



Sub Area 1		Road 4
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsC	Peru Extremely stony loam 0-20%	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.

Sub Area I		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
MyC	Munson & Raynham Silt loams 6-12% slopes	Munson - Moderate to severe: excess wetness; hazard of frost heave; topography, mainly slope.
	::	• Raynham - Moderate to severe: excess wetness; hazard of frost heave; topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe, shallow to bedrock; topography, mainly slope.
		Marlow - Severe: topography, mainly slope.

Sub Area I		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
MyC	Munson & Raynham Silt loams 6-12% slopes	Munson - Moderate to severe: excess wetness; hazard of frost heave; topography, mainly slope.
		Raynham - Moderate to severe: excess wetness; hazard of frost heave, topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe, shallow to bedrock; topography, mainly slope.
		Marlow - Severe: topography, mainly slope.

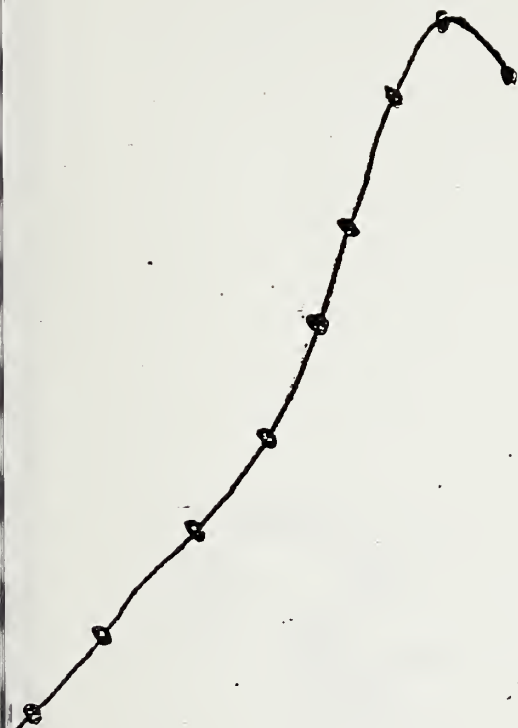




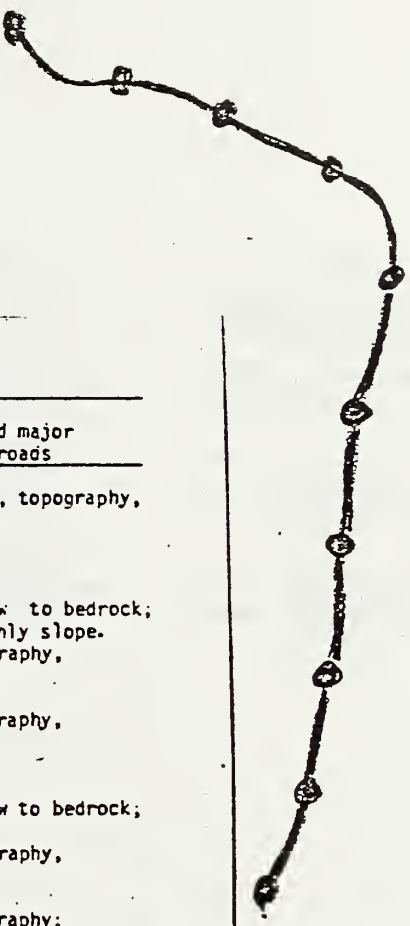
Sub Area 1		Road 6
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PC	Peacham Stony silt loam	Severe high watertable
LyD	Lyman-Marlow Very rocky loams 5-30%	Lyman - Severe: shallow to bedrock; topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area I		Road 7
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LnC	Lyman-Marlow Rocky loam 12-20%	Lyman - Severe: shallow to bedrock; topography, mainly slope.
		Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loam 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope.
		Marlow - Severe: topography, mainly slope.





Sub Area 7		Road 8
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
CaC	Cabot Stony silt loam 0-3% slope	Cabot - Severe: excess wetness; topography, mainly slope.
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.



Sub Area II		Road 1
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness, topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
MaC	Marlow Stony loam 12-20% slopes	Marlow - Severe: topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; mainly slope. Marlow - Severe: topography, mainly slope.
MaB	Marlow Stony loam 5-12% slopes	Marlow - Severe: topography; mainly slope.
CaC	Cabot Stony silt loam 3-15% slope	Cabot - Severe: excess wetness; topography, mainly slope.
PeC	Peru Stony loam 12-20% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
MyC	Munson & Raynham Silt loam 6-12% slope	Munson - Moderate to severe: excess wetness; hazard of frost heave, topography, mainly slope. Raynham - Moderate to severe: excess wetness; hazard of frost heave; topography, mainly slope.
ScB	Scantic Silt loam 2-6% slope	Severe: excess wetness.
MyB	Munson & Raynham Silt loam 2-6% slope	Munson - Moderate to severe: excess wetness; hazard of frost heave, topography, mainly slope Raynham - Moderate to severe: excess wetness, hazard of frost heave, topography, mainly slope.



Sub Area II		Road 2
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CaC	Cabot Stony silt loam 3-15% slope	Severe: excess wetness; topography, mainly slope.
LmC	Lyman-Marlow Rocky loams 12-20% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area II		Road 2
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CaC	Cabot Stony silt loam 3-15% slope	Severe: excess wetness; topography, mainly slope.
LmC	Lyman-Marlow Rocky loams 12-20% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.



Sub Area II		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CsD	Colton and Stetson soils 20-30% slope	Colton & Stetson - Slight to severe: topography, mainly slope.
PsC	Peru extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness, excess wetness; hazard of frost heave.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area II

Road 4

Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CaC	Cabot Stony silt loam 0-3% slope	Cabot - Severe: excess wetness; topography, mainly slope.
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
MaC	Marlow Stony loam 12-20% slopes	Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area II		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
StA	Stetson Gravelly fine sandy loam 0-5% slope	Stetson - Slight to severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
CbD	Cabot Extremely stony silt loam 3-25% slope	Cabot - Severe: excess wetness; topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PeB	Peru Stony loam 5-12% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.





Sub Area II		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
StA	Stetson Gravelly fine sandy loam 0-5% slope	Stetson - Slight to severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
CbD	Cabot Extremely stony silt loam 3-25% slope	Cabot - Severe: excess wetness; topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PeB	Peru Stony loam 5-12% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.

Sub Area II		Road 6
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
Add	Adams & Windsor	Severe: slope
CbD	Cabot Extremely stony silt loam 3-25% slope	Cabot - Severe: excess wetness topography, mainly slope
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave



Sub Area III		Road 1
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness, excess wetness; hazard of frost heave.
CaC	Cabot Stony silt loam 3-15% slope	Cabot - Severe: excess wetness, topography, mainly slope.
MaB	Marlow Stony loam 5-12% slopes	Marlow - Severe: topography, mainly slope.
MaC	Marlow Stony loam 12-20% slopes	Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area III

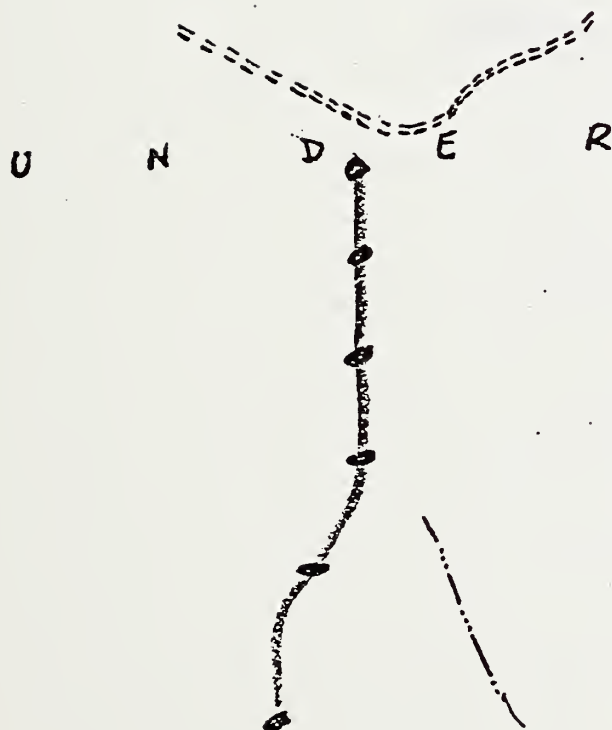
Road 2

Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

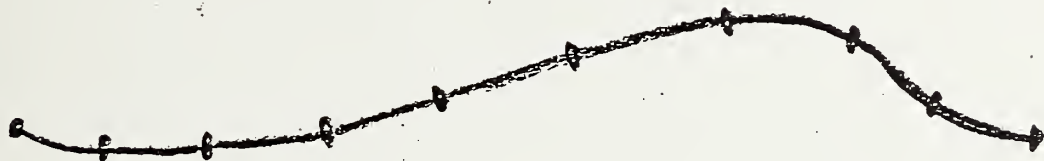


Sub Area III		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CbD	Cabot Extremely stony silt loam 3-25% slope	Cabot - Severe: excess wetness, topography, mainly slope.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
CaC	Cabot Stony silt loam 3-15% slope	Cabot - Severe: excess wetness, topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

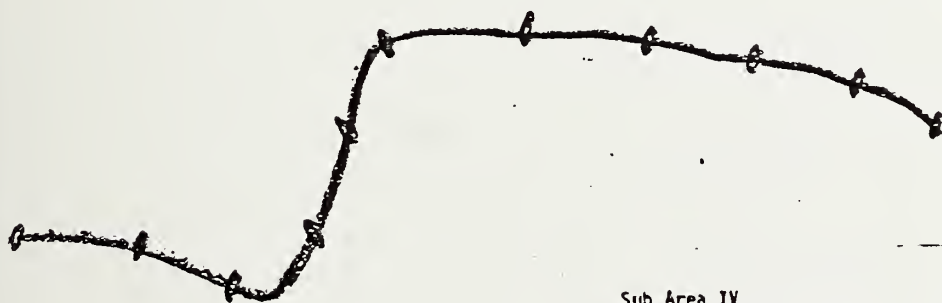
Sub Area III		Road 4
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness, excess wetness; hazard of frost heave.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.



Sub Area III		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PeC	Peru Stony loam 12-20% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; = excess wetness; hazard of frost- heave.
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
CaC	Cabot Stony silt loam 3-15% slope	Cabot - Severe: excess wetness, topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.



Sub Area IV		Road 1
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
DdB	Duane and Deerfield 5-12% slope	Severe: topography, mainly slope.
CaC	Cabot Stony silt loam 3-15% slope	Severe: excess wetness; topography, mainly slope.
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness; topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsC	Peru Extremely stoney loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.



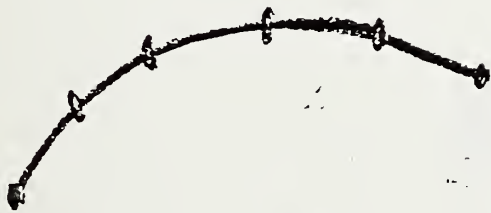
Sub Area IV		Road 2
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
StC	Stetson Gravelly fine sandy loam 12-20% slope	Severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
LmC	Lyman-Marlow Rocky loam 12-20% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
MeE	Marlow Extremely stony loam 20-60% slope	Marlow - Severe: topography, mainly slope.
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness; topography, mainly slope.

Sub Area IV		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
HiC	Hartland Very fine sandy loam	Severe: slopes loamy, subsoil or substratum
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.





Sub Area IV		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
HiC	Hartland Very fine sandy loam	Severe: slopes loamy, subsoil or substratum
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.

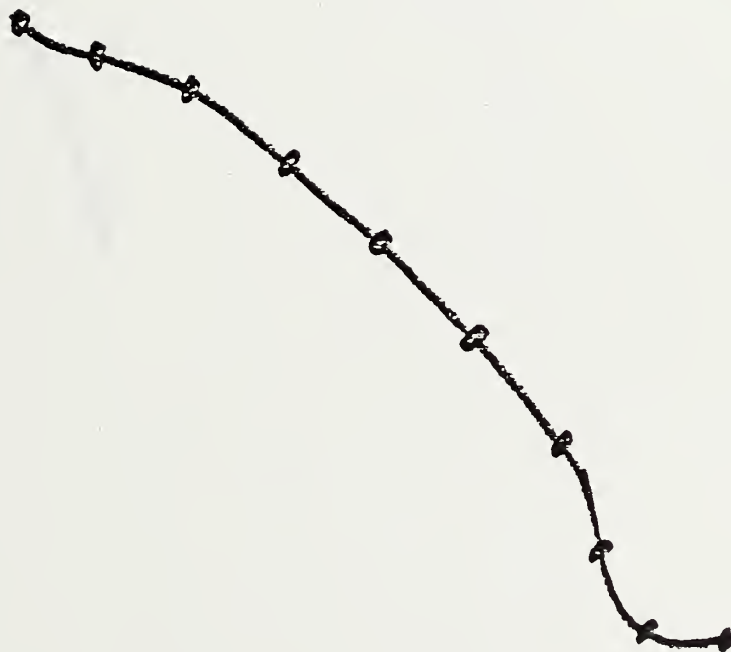


Sub Area IV		Road 4
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness; topography, mainly slope.
MeE	Marlow Extremely stony loam 20-60% slope	Severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Severe: topography, mainly slope.

Sub Area IV		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CsE	Colton and Stetson soils 30-60% slope	Slight to severe: topography, mainly slope.
HiC	Hartland Very fine sandy loam	Severe: slopes loamy subsoil or substratum.
PsC	Peru Extremely stony loam 0-20% slope	Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
StB	Stetson Gravelly fine sandy loam 5-12% slope	Slight to severe: topography, mainly slope.

Sub Area IV		Road 6
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
StB	Stetson Gravelly fine sandy loam 5-12% slope	Stetson - slight to severe: topography, mainly slope.
CsD	Colton and Stetson soils 20-30% slope	Colton & Stetson - Slight to severe: topography, mainly slope.
StC	Stetson Gravelly fine sandy loam 12-20% slope	Severe: topography, mainly slope.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.

Sub Area V		Road 1
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
StB	Stetson Gravelly fine sandy loam 5-12% slope	Stetson - Slight to severe: topography, mainly slope.
CsD	Colton and Stetson soils 20-30% slope	Colton & - Slight to severe: Stetson topography, mainly slope.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.



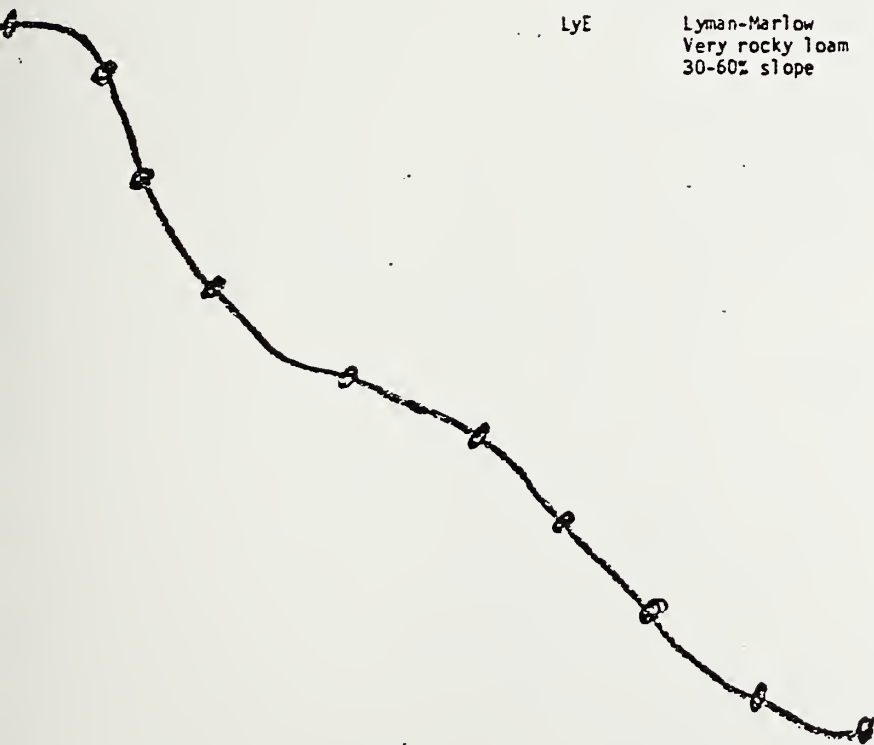
Sub Area V		Road 2
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness, topography, mainly slope.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope, excess stoniness, excess wetness; hazard of frost heave.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.



Sub Area V		Road 3
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness, excess wetness, hazard of frost heave.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness, excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock; topography, mainly slope. Marlow - Severe: topography, mainly slope.

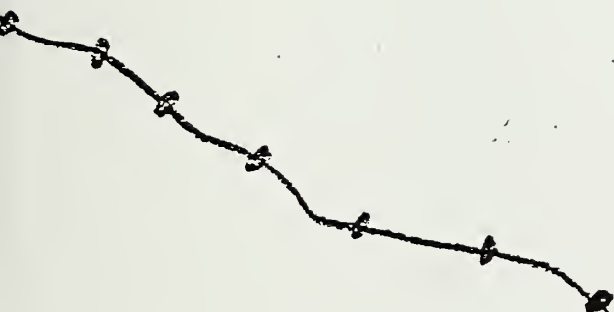


Sub Area V		Road 4
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
MaB	Marlow Stony loam 5-12% slopes	Marlow - Severe: topography, mainly slope.
MaC	Marlow Stony loam 12-20% slopes	Marlow - Severe: topography, mainly slope.
MaD	Marlow Stony loam 12-20% slopes	Marlow - Severe: topography, mainly slope.
PsC	Peru Extremely stony loam 0-20% slope	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
MeC	Marlow Extremely stony loam 5-20% slope	Marlow - Severe: topography, mainly slope.
CbD	Cabot Extremely stony silt loam 3-25% slope	Severe: excess wetness, topography, mainly slope.
LyD	Lyman-Marlow Very rocky loams 5-30% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.





Sub Area V		Road 5
Map Symbol	Soil Name	Degree of limitation and major limiting factors for roads
PeB	Peru Stony loam 5-12% slopes	Peru - Moderate to severe: topography, mainly slope; excess stoniness; excess wetness; hazard of frost heave.
PsE	Peru Extremely stony loam 20-60% slope	Peru - Moderate to severe: topography, mainly slope, excess stoniness; excess wetness; hazard of frost heave.
LyE	Lyman-Marlow Very rocky loam 30-60% slope	Lyman - Severe: shallow to bedrock, topography, mainly slope. Marlow - Severe: topography, mainly slope.





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